

Unilateral Idiopathic Osteoarthritis of the Hip

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THIS paper describes the initial results of an investigation into the possible relationship between disparity of leg length and the development of unilateral idiopathic osteoarthritis of the hip. Primary or idiopathic osteoarthritis is distinguished from that which is secondary to a predisposing condition such as trauma or developmental defect.

Danielsson¹ found primary osteoarthritis of the hip in 3.4% of persons over the age of 55. In two-thirds of these, the disease was unilateral. In patients studied for several years, the unilateral form of primary osteoarthritis did not often progress to bilateral disease.²

Primary osteoarthritis of the hip has been classified according to the pattern of damage:^{2, 3}

Medial—Central or medial degeneration and narrowing.

Lateral—Narrowing of the superolateral area of the joint with or without minor subluxation.

Mixed—Not clearly medial or lateral, usually far advanced disease.

The medial form of primary osteoarthritis, in the majority of patients, is found in both hips (Fig. 1). The lateral form of primary osteoarthritis is usually limited to one joint. The lateral type is found in approximately 2% of the population over the age of 55 and may be a discrete form of degenerative disease (Fig. 2).

Primary unilateral osteoarthritis is an interesting experiment of nature. Factors such as age, climate, diet, hormonal environment and genetic inheritance, all of which have been thought to contribute to the development of the disease, are "controlled" in the sense that the normal and diseased hip have experienced them equally. For this reason we sought a local factor that had predisposed one hip to the development of disease while sparing the other.

In this form of osteoarthritis the articular cartilage at the superior margin of the joint is narrowed and eventually destroyed. In advanced disease, the femoral head may become flattened and the acetabulum deformed, appearing to

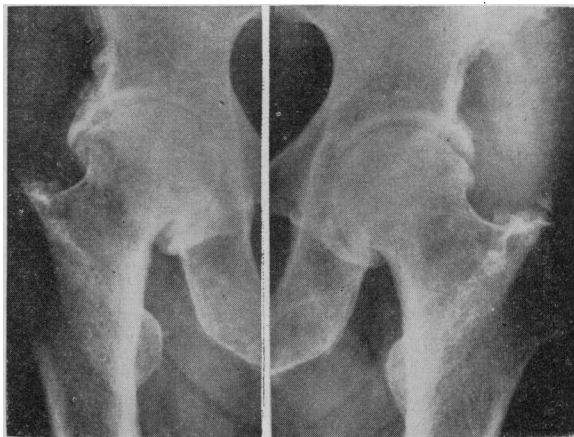


Fig. 1.—Unilateral medial osteoarthritis, which later progresses to bilateral central disease.

migrate upwards in the pelvis. These secondary changes shorten the involved leg to various degrees.

It is generally assumed that the leg on the osteoarthritic side is thereby made shorter than the normal leg. The purpose of the present communication is to demonstrate that this assumption is unfounded. The leg on the diseased side is, in fact, longer than the normal leg. We wish to propose that this disparity contributes to the development of the disease.

METHOD

The legs are measured by a radiographic method with the patient standing on a level platform. Radiographs of the pelvis are taken in



Fig. 2.—Unilateral osteoarthritis of the lateral type. Note the superolateral narrowing, the osteophytes above and below the joint, the accretions on the medial aspect of the femoral head and the normal contralateral hip.

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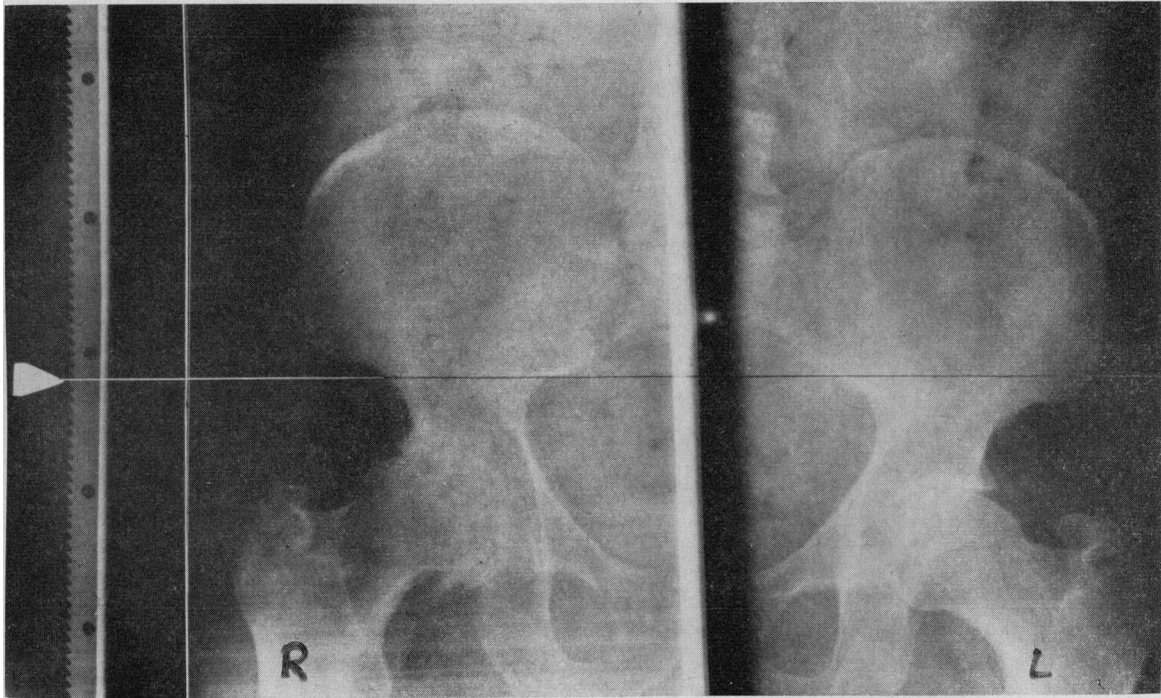


Fig. 3.—Derivation of horizontal reference line from vertical plumb-line. ► marker is 7-7½ inches from the trochanters. Difference in height of femoral heads is apparent. In this 51-year-old man, the diseased femoral head is 11/16 inch higher than the normal. (The image of the saw blade is to measure magnification.)

anteroposterior and posteroanterior projections with the beam horizontal and centred to the hip joints. The patient is positioned so that the trochanters are approximately 7½ inches from the film. The focal film distance is 6 feet. With this technique, the image is magnified 11%. Careful positioning is necessary to avoid errors produced by rotation or swaying of the patient. The method cannot be employed when a flexion or adduction deformity of the hip interferes with positioning.

A radio-opaque plumb line is suspended between the patient and the film. From the vertical image of this plumb line on the film, a horizontal reference line is derived using a T-square. The difference in height of the femoral heads is measured from this horizontal reference line (Fig. 3).

RESULTS

The leg lengths were unequal in all 14 patients with unilateral osteoarthritis of the "lateral" type (Table I). In every instance the leg on the diseased side was longer. In a few additional patients with mixed or central osteoarthritis, no clear-cut association was evident between the site of disease and a long leg. In some instances the difference in length of the diseased leg and the normal leg was small. As

mentioned previously, it is clear from examination of the radiograph of a diseased hip that the disease has produced shortening. The original leg-length disparity must therefore have been greater. An attempt was made to estimate the amount of shortening produced by the degenerative process. The width of the articular cartilage could be measured in the normal hip. This usually amounted to approximately ¼ inch.

TABLE I.—14 PATIENTS WITH UNILATERAL "LATERAL" OSTEOARTHRITIS OF THE HIP

	<i>Measured disparity</i>	<i>Estimated original disparity</i>
Over 1/2 inch.....	5	10
1/4 to 1/2 inch.....	5	4
Under 1/4 inch.....	4	0
	14	14

Comparison between the normal and diseased femoral heads allowed one to make an estimate of the amount of flattening. When these factors were taken into consideration, an original (pre-disease) leg-length difference was calculated. Of 14 patients with unilateral osteoarthritis, 10 were considered to have an original leg-length disparity greater than ½ inch.

DISCUSSION

Differences in leg length of approximately $\frac{1}{2}$ inch occur in the general population but data on the frequency of such differences are scanty. Rush and Steiner,⁴ using a radiographic measurement, showed that 15% of 1000 American soldiers had a disparity of $\frac{3}{8}$ inch (10 mm.) or greater. Others have stated that 7% of the population have a leg-length disparity of $\frac{1}{2}$ inch or more. Thus it is reasonable to postulate that no more than 15% of the general population have a leg-length disparity exceeding $\frac{1}{2}$ inch. The significance of the finding of a disparity of this magnitude in either leg in 14 patients with unilateral osteoarthritis is very high ($p < .0001$). The finding is meaningful because in all 14 patients the longer leg was on the diseased side.

It is reasonable to postulate that the difference in leg length may have predisposed to the disease, i.e. that the involved leg is originally longer than the uninvolved one. Although the degenerative process causes some shortening on the involved side, the resulting difference in leg length is not attributable to the disease alone.

A man with a leg-length difference of $\frac{1}{2}$ inch stands with a pelvic tilt of approximately 4° . The pelvis is therefore adducted towards the long leg and abducted towards the short one. In ambulation the man alternately commits his full weight to one leg, while he swings the other into position. In full stride, or in simple transfer of weight from one leg to another in moving casually about a room, the weight-bearing hip must support the head, arms, trunk, and the weight of the suspended leg. The mechanics of the hip, in these circumstances, is a complex and somewhat disputed topic. Suffice it to say that the weight-bearing hip withstands a pressure, in the mid-phase in gait, which is no less than twice the body weight, and which may be considerably greater.

It has been shown by Inman,⁵ and by Osborne and Fahrni,⁶ that the magnitude of the forces which are applied to the hip joint during walking, is greatly increased when the pelvis is adducted. In contrast they are much reduced when the pelvis is abducted.

In the presence of a leg-length difference, the pelvis is persistently adducted towards the long leg, and correspondingly abducted towards the short one. Thus the hip on the side of the long leg is subjected to stress greater than normal, while that on the short side is comparably spared. This concept is supported by the clinical observation that the hip on the normal ("short")

side remains normal in the face of steadily progressive disease in the other hip.

It is postulated that the cumulative effect of this increased stress on the hip of the long leg may be an important factor in the breaking down of joint cartilage, and the degenerative changes which follow.

It is also possible that the acetabulum and femoral head are unfavourably apposed for weight-bearing if the pelvis is persistently adducted. A minor degree of lateral subluxation of the femoral head is commonly seen in the "lateral" form of osteoarthritis. It has been postulated by some that subluxation is congenital and predisposes to the later development of the disease. The pelvic adduction produced by a long leg would seem to favour lateral subluxation of the femoral head. It is reasonable to suspect that this minor subluxation is a secondary phenomenon. When subluxation is present, the floor of the acetabulum often becomes thickened (a double acetabular floor) and accretions appear on the medial aspect of the femoral head. These secondary changes probably prevent the head from returning to its normal position, thus reinforcing the adduction deformity. The unfavourable mechanics would therefore be aggravated. It is unlikely that idiopathic unilateral osteoarthritis of the hip is simply a matter of increased stress. The average age at onset of this condition is about 55 years, suggesting that ageing cartilage may be more susceptible to stress. But the fact that the hip remains normal in most of these patients strongly supports the concept that local factors are more important than general factors in the development of this condition.

The obvious implication of this hypothesis is that we may have an opportunity to prevent this condition by detecting the early signs of stress due to disparity in leg length. Relief of the disparity, by elevating the short leg on a suitable lift, may avert or delay the disease.

Patients with a leg-length difference of $\frac{1}{4}$ to $\frac{3}{4}$ inch are usually unaware of it. However, many develop a syndrome of pain in the buttock, thigh, sometimes in the low back and occasionally in the calf. A large part of this distress is located at the insertion of the abductor muscles into the greater trochanter on the long side, suggesting that these muscles, as well as the hip, are subjected to increased stress. This syndrome occurs in patients with a long leg, whether they have osteoarthritis in the hip or not. That the pain originates at the greater trochanter can readily be demonstrated by its

immediate relief when a local anesthetic is injected into this area.

One of the most effective treatments for the relief of pain in unilateral idiopathic osteoarthritis of the hip is a subtrochanteric osteotomy. This operation has numerous modifications. It is not clear how this operation relieves the pain of an osteoarthritic hip. Because most osteotomies shorten the leg, this factor alone may explain the relief of pain which in some instances follows this procedure.

Summary The occurrence of degenerative arthritis in a single hip, in the absence of a provoking cause, suggests that increased local stress may be a contributing factor. In the majority of patients, the earliest changes in idiopathic unilateral osteoarthritis are in the superolateral portion of the joint. In a series of such patients, leg length was estimated radiologically. In all of these patients, the leg on the diseased side was *longer* than its counterpart. As the degenerative process produces shortening of the involved limb, we believe that the disparity was even greater before the onset of disease. We suggest that this disparity may produce increased stress, and alter the normal direction of forces transmitted through the hip. Either or both of these changes may contribute to the degeneration of joint cartilage.

Résumé L'apparition d'arthrite dégénérative dans une hanche, en l'absence de toute cause pouvant l'avoir provoquée, permet de croire que l'augmentation d'une agression locale peut être un facteur contributoire. Dans la majorité des cas, les modifications initiales qu'on constate dans l'ostéo-arthrite unilatérale idiopathique se produisent dans la portion supéro-latérale de l'articulation. Chez un groupe de ces malades, la longueur de la jambe a été évaluée par radiographie. Chez tous ces malades, la jambe du côté malade était *plus longue* que l'autre. Etant donné que le processus dégénératif entraîne un raccourcissement du membre atteint, nous croyons que cette disparité était encore plus marquée avant le début de la maladie. Nous estimons que cette disparité peut provoquer une augmentation du stress et peut altérer la direction des forces normales transmises par la hanche. L'un de ces deux changements, voire les deux, peut contribuer à la dégénérescence du cartilage articulaire.

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